

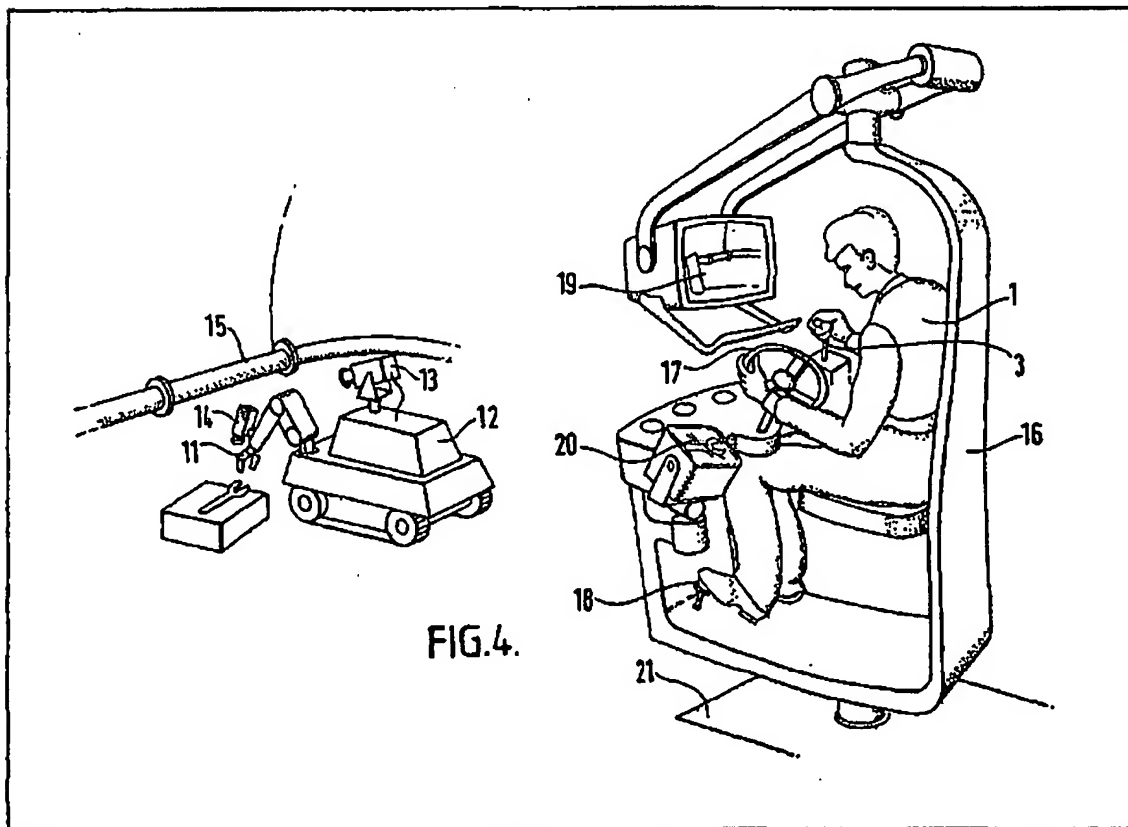
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## (54) Method of presenting visual information

(57) A method and apparatus are disclosed for presenting visual information to an operator. The apparatus comprises a movable camera (13,14) for producing an image or means for producing an image which simulates that produced by a movable camera. A monitor (19,20) presents the image to the operator in such a way that the location of the image in space moves in correspondence with the movement of the movable camera or simulation thereof. The operator may be provided with means for moving the monitor, such movement being sensed and caused to produce corresponding movement of the camera. The apparatus may be used, inter alia, for controlling and observing movement of a vehicle (12) which carries a manipulator (11).



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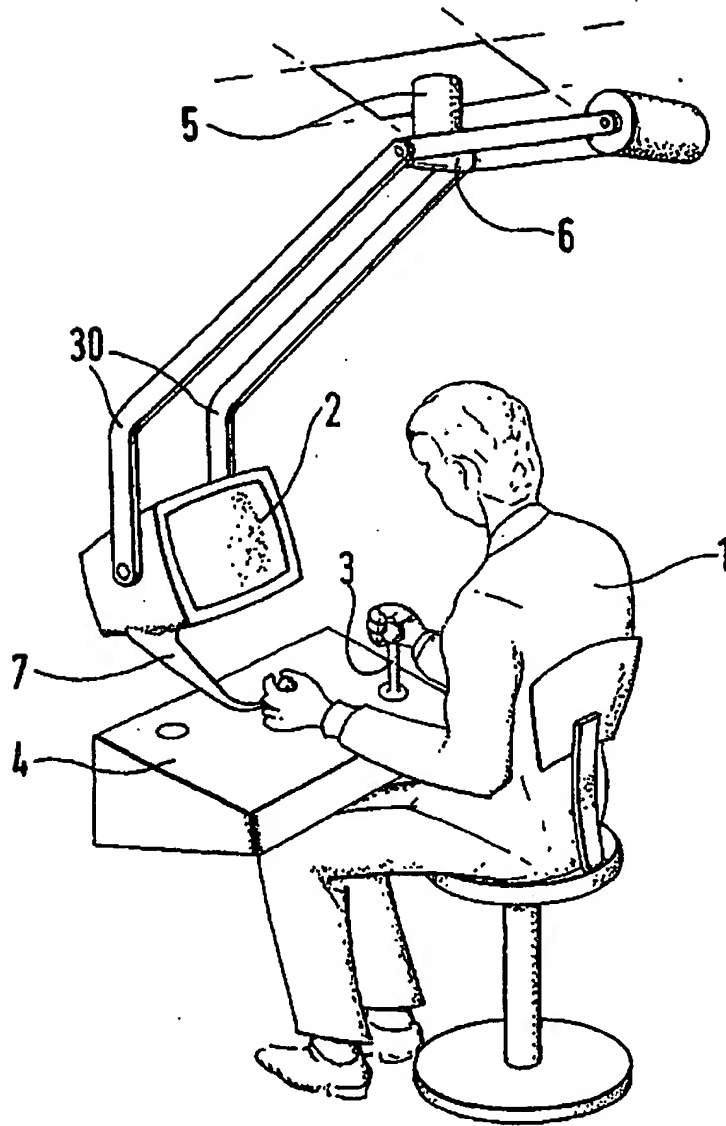


FIG.1.

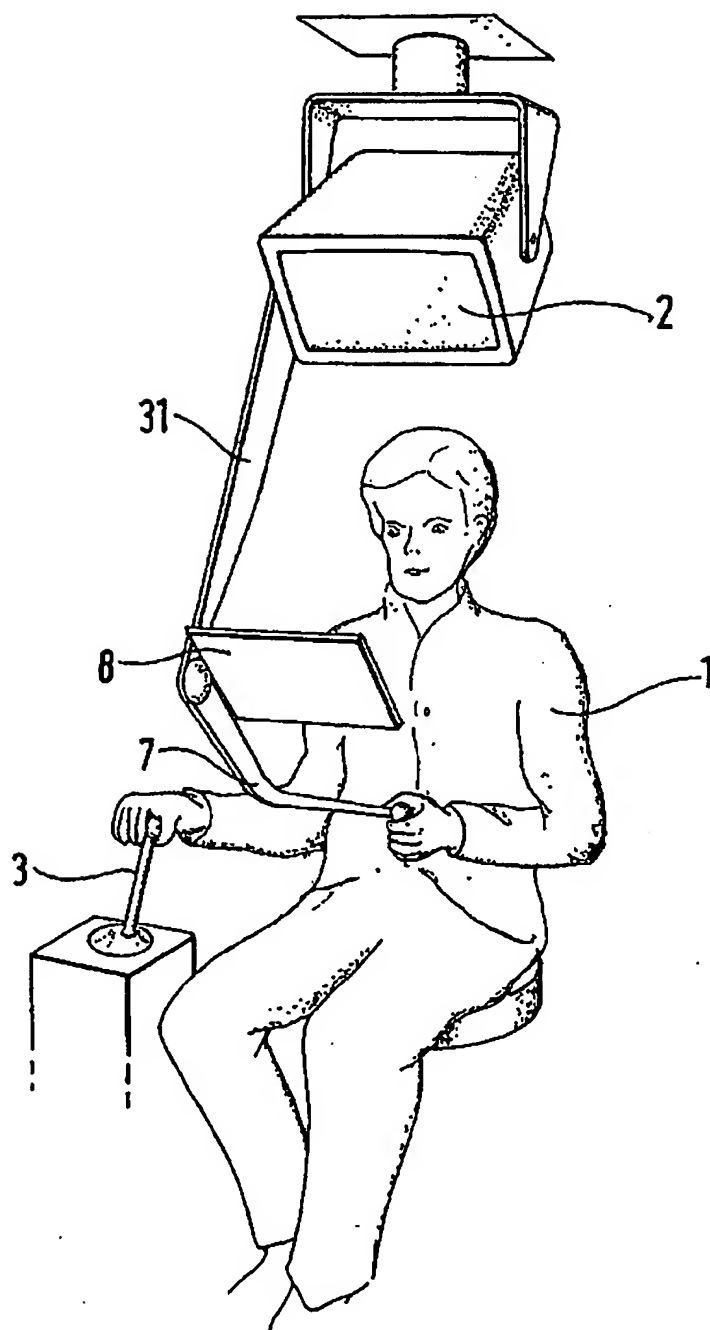


FIG.2.

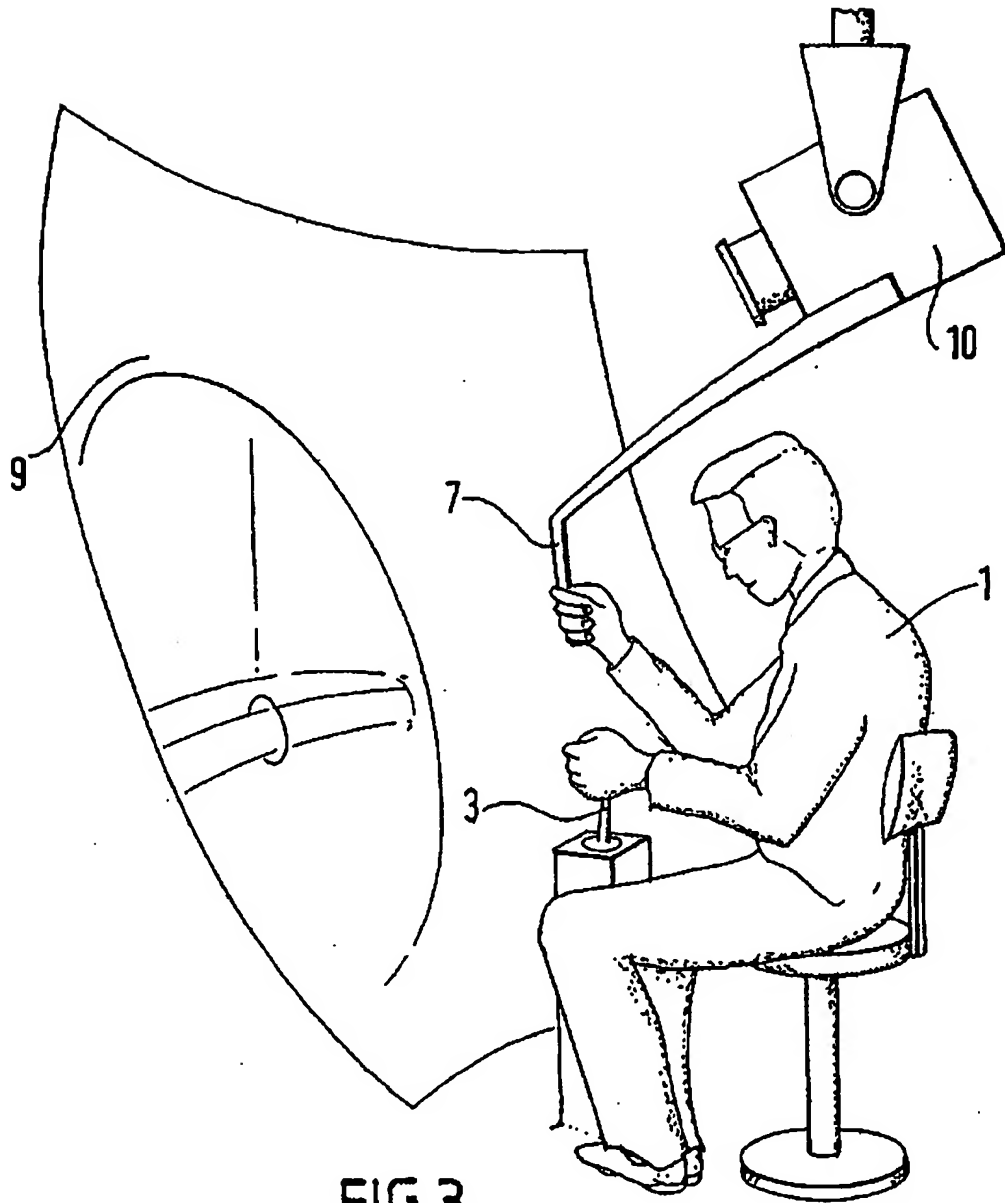


FIG. 3.

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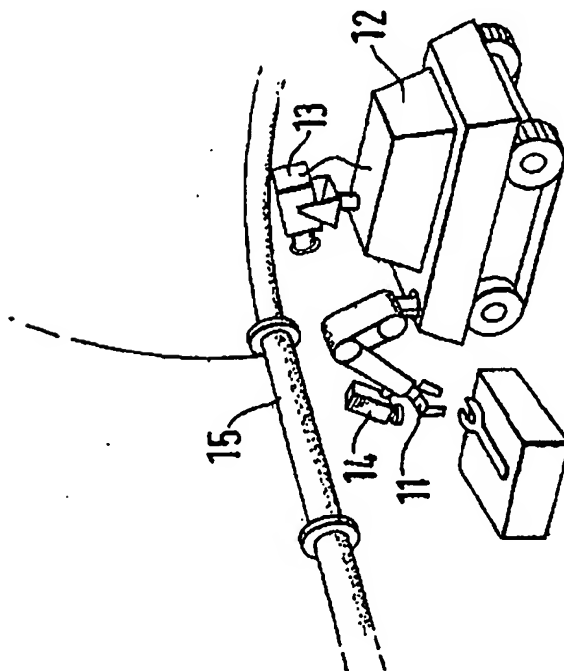
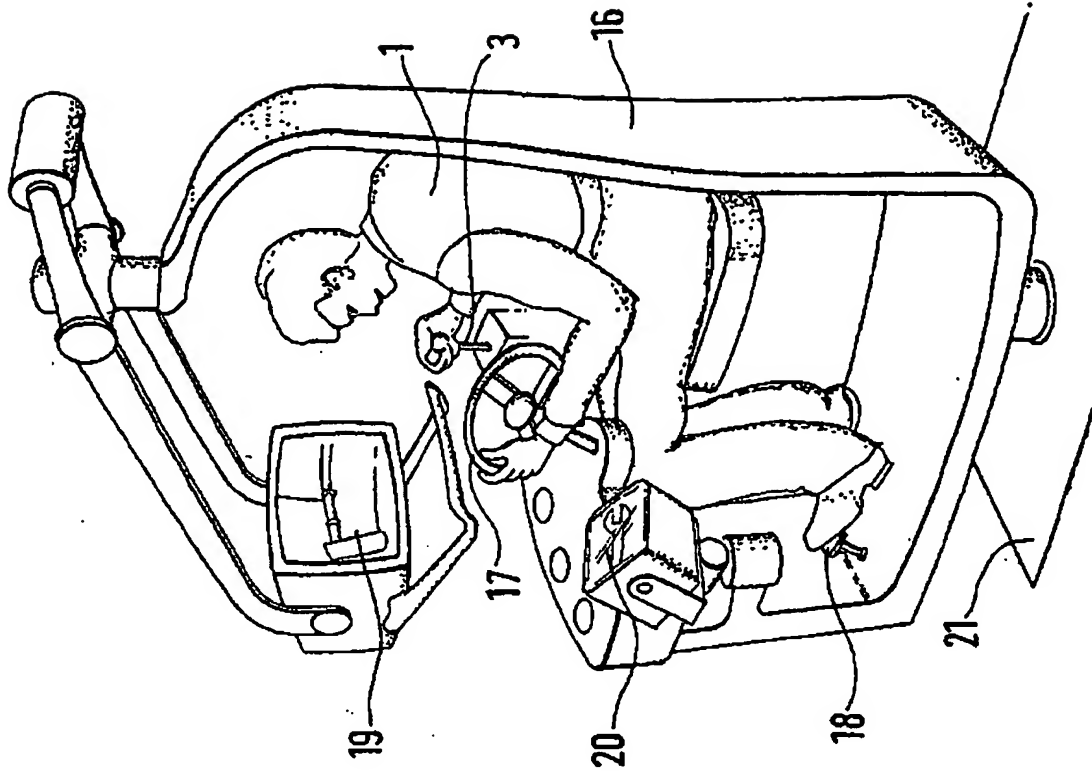
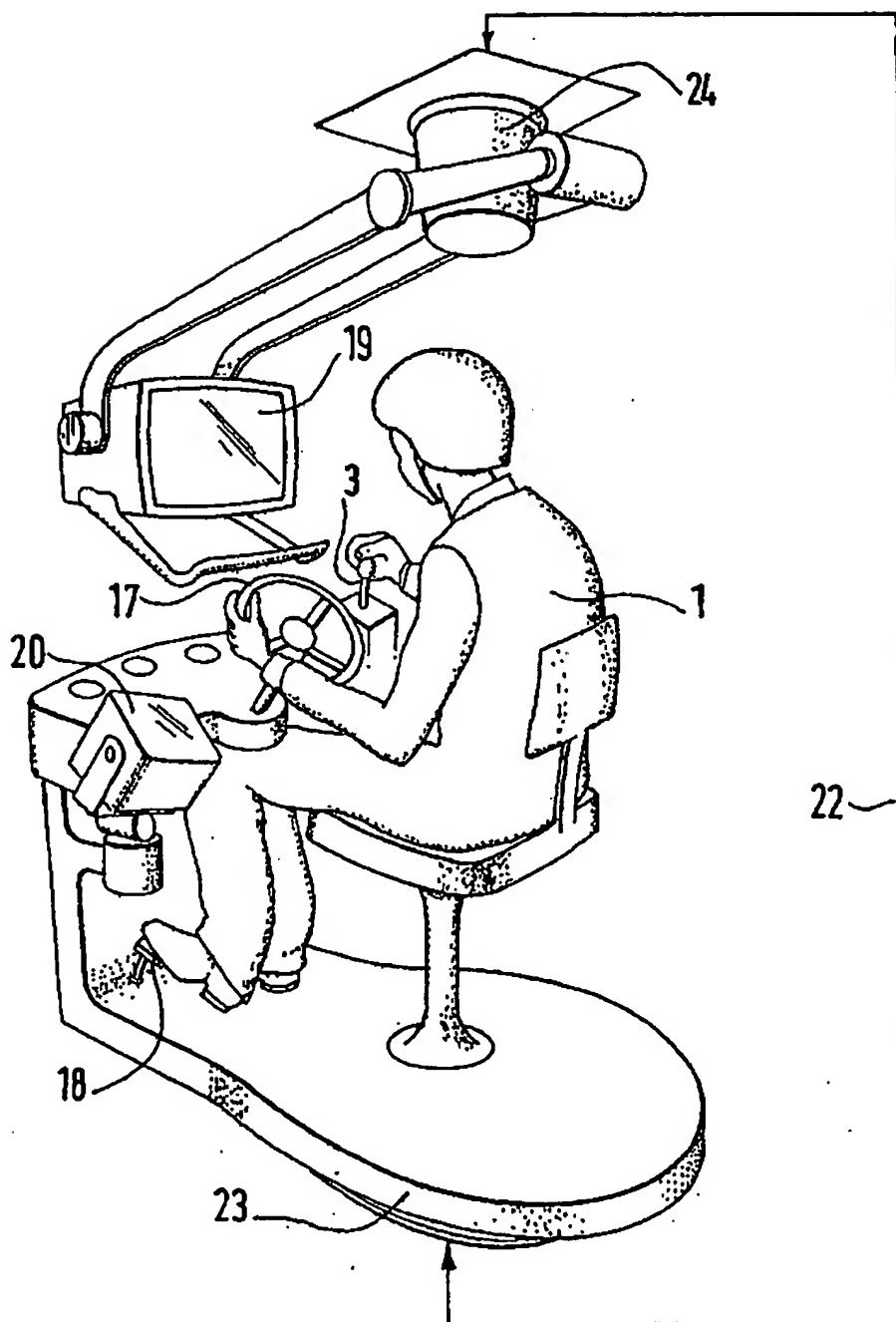


FIG. 4.

FIG.5.



# SPECIFICATION

## Method of presenting visual information

5 This invention relates to a method of presenting visual information, for example information supplied by a television camera or a computer-generated simulation of a scene.

10 There are many situations in which visual information has to be presented to an operator indirectly, i.e. with the operator not directly observing the scene concerned. One such situation arises in the handling of dangerous substances which may be carried out remotely by a manipulator. One or more movable

15 television cameras feed images back to the operator who controls the manipulator accordingly. Another situation where the indirect presentation of visual information is involved is in the control of unmanned submersible craft which are widely used for

20 carrying out inspections on and around sea-based oil rigs. Here, movement of the submersible craft is controlled by an operator who is presented with visual information by cameras movably mounted on the craft. Yet another such situation arises where the

25 operator is in a vehicle whose movement he is controlling, but where the operator is unable to view his surroundings directly but must do so via television cameras. Many other comparable situations can arise in other fields.

30 Typically the operator of a remote manipulator faces one or more television monitors receiving images from one or more cameras mounted near the manipulator. He is able, by means of knobs or joy-sticks, to control the direction of at least some of

35 the cameras, the position of the manipulator and, in the case of a manipulator mounted on a remotely controlled vehicle, the motion of the vehicle itself. Similar considerations obtain where what is involved is a remotely controlled vehicle not having a

40 manipulator thereon.

One of the chief difficulties encountered in practical operation of such systems is that the operator becomes disorientated after prolonged operation or in an unfamiliar environment, or one poor in visual

45 clues. The reason for this is that the television image does not contain any direct information about the position of the camera or its orientation. Such information can be deduced only through the interpretation of the arrangement of the objects within the image. This, of course, is possible only if either

50 the objects and their arrangement are familiar or if an accurate record of all the motions of the camera and the vehicle has been kept. In practice this means that if the operation is taking place in an unfamiliar

55 environment and the vision is not continually clear or the operator not continually watching the image the situation will inevitably arise when the positional information will be lost. Similar difficulties arise where what is being presented is a computer-

60 generated simulation of a scene.

A system is known for presenting visual information to an operator, in which the image produced by a moving camera appears on a screen which is attached to a helmet worn by the operator. The

65 screen occupies the entire field of view of one or

both eyes. As the operator moves his head this is sensed and caused to produce a corresponding movement of the camera. However, this system has been found to induce very considerable fatigue in the operators, who find it unpleasant for one or both eyes to be constantly deprived of a view of their immediate real environment.

According to the present invention, there is provided a method of presenting to an operator visual information representing a scene viewed by a moving camera or a simulation thereof, wherein the information is presented as an image whose location in space is movable, the said image and the camera or simulation thereof moving in spatial correspondence with one another.

The invention also provides an apparatus for presenting to an operator visual information derived from a movable camera or from means for producing an image which simulates that produced by a

85 movable camera, the apparatus comprising means for presenting the image to the operator in such a way that the location of the image in space moves, the said image and the camera or simulation thereof moving in spatial correspondence with one another.

The invention further provides an apparatus for presenting visual information to an operator, comprising a movable camera for producing an image or means for producing an image which simulates that produced by a movable camera, and means for

95 presenting the image to the operator in such a way that the location of the image in space moves, the said image and the camera or simulation thereof moving in spatial correspondence with one another.

Preferably the image is movable with respect to the head of the operator.

With correct choice of system parameters, e.g. viewing distance, lens focal length and so forth, the image will appear to present to the operator a moving window on an otherwise stationary scene. In

105 this way the problem of disorientation disappears or is at least alleviated.

Some embodiments of the invention are shown in the accompanying diagrammatic drawings, in which each of Figures 1 to 5 is a diagrammatic perspective view of one embodiment.

Figure 1 shows an operator 1 viewing a television monitor 2 which presents to the operator an image provided by a movable camera (not shown) mounted to survey a scene located remotely from the operator. For example, the camera could be

115 mounted to observe a manipulator located in a remotely located room. The operator controls the operation of the manipulator by means of a joy-stick 3 mounted on a console 4. The monitor 2 is mounted adjacent the operator 1 on arms 30 for pivotal movement about a vertical axis defined by a shaft 5 and about a horizontal axis defined by a shaft 6. The operator can move the monitor 2 manually by means of a handle 7. Movement of the monitor is

125 sensed by sensing means (not shown) which transmit to the remotely located camera a signal to cause corresponding movement of the camera. The operator thus indirectly controls movement of the camera by means of the handle 7. Because the

130 monitor 2 and the remote camera move in synchron-

ism the operator has the illusion of viewing a moving window on an otherwise stationary scene.

Figure 2 shows a modification of Figure 1 designed to reduce the inertia of the system. Here, the monitor 2 is mounted away from the operator 1 near the shafts defining its axes of rotation and is viewed by a lightweight mirror 8 connected to the monitor 2 by an arm 31.

Figure 3 shows a modification which uses a television image projected on a screen 9 by a projector 10. Figures 1, 2 and 3 each show the use of a single camera, but to provide a wide angle view a plurality of cameras could be used, each with its own display.

Figure 4 shows the use of the invention in controlling the movements of a manipulator 11 which is mounted on a vehicle 12. Two television cameras 13 and 14 are provided, the camera 13 being arranged to survey a workpiece 15 on which operations are to be carried out, and camera 14 being arranged to provide a close-up view of the area adjacent the manipulator, for which purpose the camera 14 is arranged to move with the manipulator 11. The operator 1 sits in a cab 16 which is mounted on a base 21 and is provided with controls 17, 18 for controlling movement of the vehicle 12 and a joy-stick 3 for controlling the manipulator 11. Two monitors 19 and 20 are mounted on the cab 16 for movement with the cab and for movement with respect to the cab 16. Operation of the joy-stick 3 causes the manipulator 11 to move carrying the camera 14 with it, and corresponding movement of the monitor 20 is produced either directly by the movement of the joy-stick 3 or indirectly by feedback from the movement of the manipulator 11. Operation of the controls 17, 18 causes movement of the vehicle 12. Angular components of this movement are detected by appropriate means, for example gyroscopes mounted on the vehicle 12, and a signal representing these components is transmitted to a drive which is capable of moving the cab 16 with respect to a base 21 on which it is mounted. This movement corresponds to the angular components of movement of the vehicle 12 so that the orientation of the cab 16 changes to match changes in the orientation of the vehicle. In this way the operator experiences changes of direction and orientation of the vehicle 12 which are produced by external factors, e.g. irregularities in the surface on which it is travelling, as well as by the steering controls. If the operator wishes to move the cameras 13 and 14 with respect to the vehicle 12 he does so by moving the monitors 19 and 20 manually. The sensed movement of the monitors produces a corresponding movement of the cameras.

Figure 5 shows part of a modified version of the embodiment of Figure 4. The modification of Figure 5 is to dispense with the cab 16 and substitute an overhead motor drive 24 for moving the monitor 18. The overhead motor drive 24 is operated by a servo connection, indicated diagrammatically by numeral 22, which connects the overhead motor drive 24 to the movable platform 23 on which the operator's chair is mounted. The servo connection 22 enables the monitor 19 to move in synchronism with move-

ment of the platform 23, except insofar as the operator himself moves the monitor 19 by means of the handle provided. The provision of the overhead motor drive 24 offers the possibility of moving the monitor 19 with respect to platform 23 by means other than the handle illustrated. For example, the motor 24 can effect such movement in response to movement of a joy-stick (not shown), in response to voice commands detected by a speech-recognition system; or in response to movement of a helmet worn by the operator as detected by an appropriate sensor.

Although the invention has been described above chiefly in relation to information provided by television cameras, it must be emphasised that it is also applicable to simulated visual images produced, for example, by computer simulation.

# CLAIMS

1. A method of presenting to an operator visual information representing a scene viewed by a moving camera or a simulation thereof, wherein the information is presented as an image whose location in space is movable, the said image and the camera or simulation thereof moving in spatial correspondence with one another.
2. An apparatus for presenting to an operator visual information derived from a movable camera or from means for producing an image which simulates that produced by a movable camera, the apparatus comprising means for presenting the image to the operator in such a way that the location of the image in space moves, the said image and the camera or simulation thereof moving in spatial correspondence with one another.
3. An apparatus according to Claim 2, wherein the movement of the image presenting means is about two orthogonal axes.
4. A apparatus according to Claim 3, wherein the image presenting means is mounted adjacent the location to be occupied by the operator on at least one arm connected to the means defining the said axes.
5. An apparatus according to Claim 2 or 3, wherein the image presenting means is mounted away from the location to be occupied by the operator, and a mirror for viewing the image presenting means is mounted adjacent the said location and connected to the image presenting means for movement therewith.
6. An apparatus according to Claim 2 or 3, wherein the image presenting means is arranged to project the said image onto a screen for viewing by the operator.
7. An apparatus for presenting visual information to an operator, comprising a movable camera for producing an image or means for producing an image which simulates that produced by a movable camera, and means for presenting the image to the operator in such a way that the location of the image in space moves, the said image and the camera or simulation thereof moving in spatial correspondence with one another.
8. An apparatus according to Claim 7, wherein



the movement of the image presenting means is about two orthogonal axes.

9. An apparatus according to Claim 8, wherein the image presenting means is mounted adjacent the location to be occupied by the operator on at least one arm connected to means defining the said axes.

10. An apparatus according to Claim 7 or 8, wherein the image presenting means is mounted away from the location to be occupied by the operator, and a mirror for viewing the image presenting means is mounted adjacent the said location and connected to the image presenting means for movement therewith.

11. An apparatus according to Claim 7 or 8, wherein the image presenting means is arranged to project the said image onto a screen for viewing by the operator.

12. An apparatus according to any one of Claims 7 to 11, wherein the image presenting means comprises a monitor movable by the operator, the apparatus comprising means for sensing movement of the monitor and means, responsive to the said sensing means, for moving the camera or simulating movement of the camera.

13. An apparatus according to any one of Claims 7 to 12, further comprising means operable by the operator for controlling a movable tool positioned in the field of view of the movable camera.

14. An apparatus according to Claim 13, wherein the movable camera is mounted for movement with the tool.

15. An apparatus according to Claim 13, wherein the movable camera is so mounted that the tool is movable with respect to the camera.

16. An apparatus according to any one of Claims 7 to 12, for use where the operator is to control movement of a vehicle on which the movable camera is mounted, comprising an operator station defining the location to be occupied by the operator, operating-controlled means for controlling the movement of the vehicle, and means for effecting angular movement of the operator station to correspond with angular movement of the vehicle.

17. An apparatus according to Claim 16, wherein the means for effecting angular movement of the operator station comprises means for sensing movement of the vehicle to correspond therewith.

18. An apparatus according to Claim 16 or 17, wherein the operator station comprises a cab on which the image presenting means is mounted.

19. An apparatus according to Claim 16 or 17, wherein the image presenting means is mounted independently of the operator station and is operatively connected to the operator station for movement in synchronism therewith.

20. An apparatus according to any one of Claims 16 to 19, for use where the vehicle carries a movable tool, wherein an additional camera is mounted for movement with the tool and an additional image presenting means is provided for the operator to view the image produced by the said additional camera.

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